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AN 130:190457 HCA
TI High-strength **copper** alloy showing excellent stamping workability and silver platability
IN Ogura, Tetsuzo; Hosokawa, Isao; Hamamoto, Takashi; Mitsuwa, Yousuke; Isono, Masaaki
PA Kobe Steel, Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 9 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 11043731	A2	19990216	JP 1997-214149	19970723

AB The **Cu** alloy contains **Ni** 0.4-4.0, **Si** 0.05-1.0, **Sn** 0.001-5.0, **Zn** 0.1-5.0, **Mg** 0.005-1.0, S 0.0003-0.005, and C 0.0003-0.01 wt.% and satisfies (0.5Mg + S .gtoreq.0.005, 0.25Mg .gtoreq.S). The **Cu** alloy may have av. crystal grain size .ltoreq.20 .mu.m. The alloy may further contain 0.001-1.0 wt.% (as total) of Be, B, Al, P, Ti, V, Cr, Mn, Fe, Co, Pb, Ca, Zr, Nb, Mo, Ag, In, Sb, Hf, and/or Ta. The alloy has satisfactory strength, elec. cond. for being used as elec. parts and inhibits generation of protrusion on formed Ag plating.

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(71)出願人　000001199
株式会社神戸製鋼所
兵庫県神戸市中央区脇浜町１丁目３番18号
(72)発明者　小倉　哲造
山口県下関市長府港町14番１号　株式会社神戸製鋼所長府製造所内
(72)発明者　細川　功
山口県下関市長府港町14番１号　株式会社神戸製鋼所長府製造所内
(72)発明者　濱本　孝
山口県下関市長府港町14番１号　株式会社神戸製鋼所長府製造所内
(74)代理人　弁理士　香本　薫

最終頁に続く

(54)【発明の名称】　スタンピング加工性及び銀めっき性に優れる高力銅合金

(57)【要約】
【課題】　スタンピング加工性と銀めっき性の双方の特性に優れたＣｕ－Ｎｉ－Ｓｉ系高力銅合金を得る。
【解決手段】　Ｎｉ：０．４～４．０ｗｔ％、Ｓｉ：０．０５～１．０ｗｔ％、Ｓｎ：０．００１～５ｗｔ％、Ｚｎ：０．１～５．０ｗｔ％、Ｍｇ：０．００５～１．０ｗｔ％、Ｓ：０．０００３～０．００５ｗｔ％、Ｃ：０．０００３～０．０１ｗｔ％を含有し、残部Ｃｕ及び不可避不純物からなり、さらにＭｇとＳの含有量が下記式（１）及び（２）を同時に満たすＣｕ－Ｎｉ－Ｓｉ系高力銅合金。
$-0.5[Mg]+0.005 \leqq [S]$ ・・・・（１）
$[S] \leqq 0.25[Mg]$ ・・・・（２）
ただし、[Ｍｇ]はＭｇのｗｔ％、[Ｓ]はＳのｗｔ％を意味する。

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【特許請求の範囲】

【請求項1】 Ni：0．4～4．0wt%、Si：0．05～1．0wt%、Sn：0．001～5．0wt%、Zn：0．1～5．0wt%、Mg：0．005～1．0wt%、S：0．0003～0．005wt%、C：0．0003～0．01wt%を含有し、残部Cu及び不可避不純物からなり、さらにMgとSの含有量が下記式（1）及び（2）を同時に満たすことを特徴とするスタンピング加工性及び銀めっき性に優れる高力銅合金。

0．5[Mg]+[S]≧0．005‥‥（1）

0．25[Mg]≧[S]　　‥‥（2）

（[Mg]はMgのwt%、[S]はSのwt%を意味する、以下同じ）

【請求項2】 Ni：0．4～4．0wt%、Si：0．05～1．0wt%、Sn：0．001～5．0wt%、Zn：0．1～5．0wt%、Mg：0．005～1．0wt%、S：0．0003～0．005wt%、C：0．0003～0．01wt%を含有し、残部Cu及び不可避不純物からなり、さらにMgとSの含有量が下記式（1）及び（2）を同時に満たすとともに、板厚方向の平均結晶粒径が20μm以下であることを特徴とするスタンピング加工性及び銀めっき性に優れる高力銅合金。

0．5[Mg]+[S]≧0．005‥‥（1）

0．25[Mg]≧[S]　　‥‥（2）

【請求項3】 Ni：0．4～4．0wt%、Si：0．05～1．0wt%、Sn：0．001～5．0wt%、Zn：0．1～5．0wt%、Mg：0．005～1．0wt%、S：0．0003～0．005wt%、C：0．0003～0．01wt%を含有し、副成分としてBe、B、Al、P、Ti、V、Cr、Mn、Fe、Co、Pb、Ca、Zr、Nb、Mo、Ag、In、Sb、Hf、Taのうち1種又は2種以上を総量で0．001～1．0wt%含有し、残部Cu及び不可避不純物からなり、さらにMgとSが下記式（1）及び（2）を同時に満たすことを特徴とするスタンピング加工性及び銀めっき性に優れる高力銅合金。

0．5[Mg]+[S]≧0．005‥‥（1）

0．25[Mg]≧[S]　　‥‥（2）

【請求項4】 Ni：0．4～4．0wt%、Si：0．05～1．0wt%、Sn：0．001～5．0wt%、Zn：0．1～5．0wt%、Mg：0．005～1．0wt%、S：0．0003～0．005wt%、C：0．0003～0．01wt%を含有し、副成分としてBe、B、Al、P、Ti、V、Cr、Mn、Fe、Co、Pb、Ca、Zr、Nb、Mo、Ag、In、Sb、Hf、Taのうち1種又は2種以上を総量で0．001～1．0wt%含有し、残部Cu及び不可避不純物からなり、さらにMgとSが下記式（1）及び

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（2）を同時に満たすとともに、板厚方向の平均結晶粒径が20μm以下であることを特徴とするスタンピング加工性および銀めっき性に優れる高力銅合金。

0．5[Mg]+[S]≧0．005‥‥（1）

0．25[Mg]≧[S]　　‥‥（2）

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、半導体リードフレーム、端子、コネクタ、リレー、スイッチなどの電気・電子部品に使用されるスタンピング加工性及び銀めっき性に優れる高力銅合金に関するものである。

【0002】

【従来の技術】Cu-Ni-Si系銅合金は、強度と導電率を兼備することから、半導体リードフレーム、端子、コネクタなどの電気・電子部品に広く使用されている。近年、電気・電子部品の小型化、軽量化、高集積化に伴い、リードフレームのリード間隔の縮小あるいはコネクタの極間ピッチの縮小が図られている。これにより高強度化、高導電率化の要求はもとより、スタンピング加工性（スタンピング加工後のばり、だれなどが少ないこと）に優れ、スタンピング金型を摩耗させない材料の要求が増大している（例えば、特開平2-66130号公報参照）。また、これらの電気・電子部品は銀めっきされることがあるが、信頼性の向上要求増大により、従来にも増して、銀めっき性が重要視されるようになってきている（例えば、特開昭63-130739号公報、特開平5-59468号公報、特開平8-319528号公報参照）。

【0003】

【発明が解決しようとする課題】電気・電子部品用Cu-Ni-Si系銅合金において、導電率の低下を抑えて強度の向上を図る添加元素としてMgが使用される。そして、Mgは、上記特開平2-66130号公報に記載されているように、スタンピング加工性及び金型摩耗の低減にも効果が大きいが、一方、微量でも銀めっき性を劣化（銀めっきの突起を発生）させることが知られている。本発明は、Mgを含有するCu-Ni-Si系高力銅合金において、スタンピング加工性と銀めっき性という従来は相反すると考えられていた特性を両立させることを目的としたものである。

【0004】

【課題を解決するための手段】本発明に係るスタンピング加工性及び銀めっき性に優れる高力銅合金は、Ni：0．4～4．0wt%、Si：0．05～1．0wt%、Sn：0．001～5．0wt%、Zn：0．1～5．0wt%、Mg：0．005～1．0wt%、S：0．0003～0．005wt%、C：0．0003～0．01wt%を含有し、残部Cu及び不可避不純物からなり、さらにMgとSの含有量が下記式（1）及び（2）を同時に満たすことを特徴とする。

0．5［Mg］＋［S］≧0．005‥‥（1）

0．25［Mg］≧［S］　　‥‥（2）

【0005】上記銅合金は、副成分として、Be、B、Al、P、Ti、V、Cr、Mn、Fe、Co、Pb、Ca、Zr、Nb、Mo、Ag、In、Sb、Hf、Taのうち1種又は2種以上を総量で0．001～1．0wt％含有することができる。また、板厚方向の平均結晶粒径が20μm以下であることが好ましい。

【0006】

【発明の実施の形態】以下、本発明に係る銅合金の成分及び結晶粒径の限定理由について説明する。

（Ni）NiはSiとともに添加することにより、NiとSiの化合物を生成し、合金の強度を向上させる作用を有する元素である。しかし、0．4wt％未満ではこの効果が小さく、4．0wt％を超えて含有すると熱間加工性及び冷間加工性が劣化するので好ましくない。従って、Niの含有量は0．4～4．0wt％とする。

【0007】（Si）SiはNiとともに添加することにより、NiとSiの化合物を生成し、合金の強度を向上させる作用を有する元素である。しかし、0．05wt％未満ではこの効果が小さく、また1．0wt％を超えて含有すると、熱間加工性及び冷間加工性が劣化するので好ましくない。従って、Siの含有量は0．05～1．0wt％とする。

【0008】（Sn）Snは強度、ばね特性及び耐応力緩和特性を向上させる元素である。しかし、0．001wt％未満ではこの効果は小さく、5．0wt％を超えて含有しても効果が飽和するとともに、熱間加工性の劣化及び導電率の低下を招くので好ましくない。

【0009】（Zn）Znは錫及び錫合金めっきの耐熱剥離性を向上させ、さらに耐マイグレーション性をも向上させる元素である。しかし、0．1wt％未満ではこれらの効果は小さく、5．0wt％を超えて含有しても効果が飽和するとともに、導電率の低下、耐応力腐食割れ感受性の増大を招くので好ましくない。従って、Znの含有量は0．1～5．0wt％とする。

【0010】（Mg）Mgは強度、耐応力緩和特性及びスタンピング加工性を向上させるとともに、金型摩耗の低減にも効果がある元素である。0．005wt％未満ではその効果は小さく、1．0wt％を超えて含有してもその効果が飽和するとともに、鋳造性、熱間加工性の劣化、及び導電率の低下を招くので好ましくない。従って、Mgの含有量は0．005～1．0wt％とする。さらにMgは、以下に述べるとおり、Sとの相互作用で銀めっき性にも関与する。

【0011】（S）SはMgとともにスタンピング加工性を向上させる反面、銀めっき時の銀突起を発生させやすい元素でもある。0．0003wt％未満ではスタンピング加工性を向上させる効果が小さく、0．005wt％を超えて含有すると銀めっき性及び熱間加工性を劣化させる。従って、Sの含有量は0．0003～0．005wt％とする。

【0012】（Mg及びSの関係）Mgを含有するCu－Ni－Si系高力銅合金において、スタンピング加工性及び銀めっき性を両立させるために、以下の範囲に両成分を限定する必要があることを本発明者らは見い出した。まず、スタンピング加工性の面からはMg及びSは多い方が望ましく、最低限下記式（1）を満たすことが必要である。

0．5［Mg］＋［S］≧0．005‥‥（1）

【0013】次に、銀めっき性の面からは以下のような考え方でその比率を制御することが必要である。すなわち、銀突起の主原因はMgとSが結合して生成したMgSであり、それが銅合金の中に局在化することにより、その部分の局部的な電位が低くなり、銀の局部的な析出が起こるためである。しかし、Mgの含有量が十分に多いと、銅中に固溶するMgが銅合金のマトリックスとMgSとの間の電位差を小さくしてくれるため、銀の局部的な析出が起こりにくくなる。従って、MgはSとの比率で多い方が望ましく、最低限下記式（2）を満たすことが必要である。

0．25［Mg］≧［S］　　‥‥（2）

【0014】（C）CはMgを含有するCu－Ni－Si系銅合金のスタンピング加工性を向上させる作用があることを本発明者らは見い出した。しかし、0．0003wt％未満ではその効果は小さく、0．01wt％を超えて含有するとその効果が飽和するとともに、熱間加工性を劣化させる。したがって、Cの含有量は0．0003～0．01wt％、好ましくは0．001～0．01wt％とする。

【0015】（副成分）Be、B、Al、P、Ti、V、Cr、Mn、Fe、Co、Pb、Ca、Zr、Nb、Mo、Ag、In、Sb、Hf、Taの副成分は、強度とスタンピング加工性をさらに向上させる目的で、導電率の低下が許される範囲で添加することができる元素である。これらの元素の1種又は2種以上の総量が0．001wt％未満では強度向上効果が小さく、1wt％を超えて含有すると、導電率の低下が著しくなり好ましくない。したがって、これらの副成分の総量を0．001～1wt％とする。

【0016】（結晶粒径）Mgを含有するCu－Ni－Si系銅合金において、特に板厚方向の結晶粒径がスタンピング加工性に関与することを本発明者らは見い出した。最終板製品状態での板厚方向の平均結晶粒径が20μm以下であればスタンピング加工性を向上させることができる。望ましくは15μm以下である。再結晶段階で20μmを超す結晶粒径であったとしても、その後の冷間加工により結晶粒が偏平となり、板厚方向の平均結晶粒径が20μm以下となる場合は、これに含まれる。なお、再結晶後に合計90％以上の冷間加工を施した材

料に認められる、いわゆるファイバー組織の場合は結晶粒は観察困難であるが、このようなファイバー組織も本発明に含まれる。

【００１７】

【実施例】本発明に係るスタンピング加工性及び銀めっき性に優れる高力銅合金の実施例について、その比較例とともに以下に説明する。表１～４に示す成分組成の銅合金を、クリプトル炉にて木炭被覆下で大気溶解し、ブックモールドに鋳造し、５０ｍｍ×８０ｍｍ×２００ｍｍの鋳塊を作製した。この鋳塊を９３０℃に加熱し熱間＊10＊圧延後、ただちに水中急冷し厚さ１５ｍｍの熱延材とした。この熱延材の表面の酸化スケールを除去するため、表面をグラインダで切削した。この熱延材を冷間圧延で厚さ０．３６ｍｍとし、６５０～８５０℃で２０秒間熱処理した後水中急冷した。さらに厚さ０．２５ｍｍまで冷間圧延し、４５０～５００℃で２時間の焼鈍を施し、表面の酸化皮膜を酸洗にて除去後試験に供した。

【００１８】

【表１】

表-1

		主成分（ｗｔ％）								副成分
	No.	Cu	Ni	Si	Sn	Zn	Mg	S	C	（ｗｔ％）
実施例	1	残部	0.9	0.2	0.5	1.0	0.10	0.0015	0.0030	－
	2	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	－
	3	残部	3.2	0.7	0.5	1.0	0.10	0.0015	0.0030	－
	4	残部	1.8	0.4	0.01	1.0	0.10	0.0015	0.0030	－
	5	残部	1.8	0.4	0.1	1.0	0.10	0.0015	0.0030	－
	6	残部	1.8	0.4	3.0	1.0	0.10	0.0015	0.0030	－
	7	残部	1.8	0.4	0.5	0.3	0.10	0.0015	0.0030	－
	8	残部	1.8	0.4	0.5	3.0	0.10	0.0015	0.0030	－
	9	残部	1.8	0.4	0.5	1.0	0.01	0.0015	0.0030	－
	10	残部	1.8	0.4	0.5	1.0	0.30	0.0015	0.0030	－
	11	残部	1.8	0.4	0.5	1.0	0.70	0.0015	0.0030	－
	12	残部	1.8	0.4	0.5	1.0	0.10	0.0005	0.0030	－
	13	残部	1.8	0.4	0.5	1.0	0.10	0.0040	0.0030	－
	14	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0015	－
	15	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0080	－

【００１９】　　※　※【表２】

表-2

		主成分（wt%）								副成分
	No.	Cu	Ni	Si	Sn	Zn	Mg	S	C	(wt%)
実施例	16	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Be：0.1 B：0.04 Al：0.008
	17	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	P：0.03 Ti：0.02 V：0.006
	18	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Cr：0.005 Mn：0.04 Fe：0.02
	19	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Co：0.03 Zr：0.02 Nb：0.01
	20	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Mo：0.005 Ag：0.03 In：0.08
	21	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Sb：0.07 Hf：0.009 Ta：0.01
	22	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Pb：0.02 Ca：0.005

【0020】　　＊　＊【表3】

表-3

		主成分（wt%）								副成分
	No.	Cu	Ni	Si	Sn	Zn	Mg	S	C	(wt%)
比較例	23	残部	0.3	0.4	0.5	1.0	0.10	0.0015	0.0030	−
	24	残部	4.5	0.4	0.5	1.0	0.10	0.0015	0.0030	−
	25	残部	5.0	1.1	0.5	1.0	0.10	0.0015	0.0030	−
	26	残部	1.8	0.4	0.0005	1.0	0.10	0.0015	0.0030	−
	27	残部	1.8	0.4	6.0	1.0	0.10	0.0015	0.0030	−
	28	残部	1.8	0.4	0.5	0.05	0.10	0.0015	0.0030	−
	29	残部	1.8	0.4	0.5	6.0	0.10	0.0015	0.0030	−
	30	残部	1.8	0.4	0.5	1.0	0.003	0.0015	0.0030	−
	31	残部	1.8	0.4	0.5	1.0	1.2	0.0015	0.0030	−
	32	残部	1.8	0.4	0.5	1.0	0.10	0.0002	0.0030	−
	33	残部	1.8	0.4	0.5	1.0	0.10	0.006	0.0030	−
	34	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0001	−
	35	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0120	−

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【0021】　　※　※【表4】

表-4

	No.	主成分（wt%） Cu	Ni	Si	Sn	Zn	Mg	S	C	副成分 (wt%)
比較例	36	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Be：0.1 * B：0.04 Al：1.2
	37	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	P：0.6 * Ti：0.5 V：0.006
	38	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Cr：0.5 * Mn：0.04 Fe：0.7
	39	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Co：1.3 * Zr：0.02 Nb：0.01
	40	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Mo：0.005 Ag：0.03 In：1.2 *
	41	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Sb：1.1 * Hf：0.009 Ta：0.01
	42	残部	1.8	0.4	0.5	1.0	0.015	0.004	0.0030	－
	43	残部	1.8	0.4	0.5	1.0	0.006	0.0015	0.0030	－

ｱﾝﾀﾞｰﾗｲﾝの箇所又は*印の箇所は本発明の範囲外

【００２２】この供試材について、下記要領にて引張強さ、導電率、結晶粒径、スタンピング加工性、銀めっき性及びはんだ耐熱剥離性を調査した。これらの結果を表５及び表６に示す。引張強さは、ＪＩＳ５号試験片を用いた。導電率はダブルブリッジ法にて測定した。結晶粒径は、ＪＩＳＨ０５０１に規定する伸銅品結晶粒度試験方法の切断法により、板厚方向に測定した。スタンピング加工性の評価は、プレスにより長さ３０ｍｍ、幅０．５ｍｍのリードを打抜き、ばりの高さを測定した。銀め＊っき性は、シアン系銀めっきを厚さ１μｍ施したときに、局所的にめっき厚さが厚くなる現象（突起）の有無を実体顕微鏡で観察した。はんだ耐熱剥離性は、２４５℃のはんだ浴（６０Ｓｎ／４０Ｐｂ）に5秒間浸漬して約２０μｍのめっき層を被覆した材料を１５０℃で１０００時間加熱後、１８０°曲げて平板に戻した後はんだめっき層の剥離の有無を観察した。

【００２３】

【表５】

表-5

	No.	熱間加工性	引張強さ (N/mm²)	導電率 (%IACS)	平均結晶粒径(μm)	ばり高さ (μm)	銀突起有無	はんだ剥離 有無
実施例	1	良好	580	45	7.5	8	無し	無し
	2	良好	730	43	7.5	5	無し	無し
	3	良好	900	40	7.5	3	無し	無し
	4	良好	710	48	7.5	5	無し	無し
	5	良好	720	47	7.5	5	無し	無し
	6	良好	770	30	7.5	5	無し	無し
	7	良好	720	44	7.5	5	無し	無し
	8	良好	740	42	7.5	5	無し	無し
	9	良好	710	44	7.5	7	無し	無し
	10	良好	750	41	7.5	4	無し	無し
	11	良好	780	38	7.5	3	無し	無し
	12	良好	730	43	7.5	7	無し	無し
	13	良好	730	43	7.5	3	無し	無し
	14	良好	730	43	7.5	7	無し	無し
	15	良好	730	43	7.5	3	無し	無し
	16	良好	800	37	7.5	3	無し	無し
	17	良好	770	38	7.5	3	無し	無し
	18	良好	740	42	7.5	4	無し	無し
	19	良好	750	42	7.5	4	無し	無し
	20	良好	760	41	7.5	3	無し	無し
	21	良好	750	41	7.5	3	無し	無し
	22	良好	750	41	7.5	2	無し	無し

【0024】　　＊　＊【表6】

表-6

	No.	熱間加工性	引張強さ (N/mm²)	導電率 (%IACS)	平均結晶粒径(μm)	ばり高さ (μm)	銀突起有無	はんだ剥離 有無
比較例	23	良好	530	36	7.5	10	無し	無し
	24	割れ	－	－	－	－	－	－
	25	割れ	－	－	－	－	－	－
	26	良好	700	43	7.5	5	無し	無し
	27	割れ	－	－	－	－	－	－
	28	良好	730	45	7.5	5	無し	有り
	29	良好	740	34	7.5	5	無し	無し
	30	良好	690	44	7.5	16	無し	無し
	31	割れ	－	－	－	－	－	－
	32	良好	780	38	7.5	15	無し	無し
	33	割れ	－	－	－	－	－	－
	34	良好	730	43	7.5	17	無し	無し
	35	割れ	－	－	－	－	－	－
	36	良好	890	24	7.5	3	無し	無し
	37	良好	960	9	7.5	3	無し	無し
	38	良好	770	31	7.5	3	無し	無し
	39	良好	760	29	7.5	3	無し	無し
	40	良好	790	30	7.5	3	無し	無し
	41	良好	800	28	7.5	3	無し	無し
	42	良好	710	43	7.6	5	有り	無し
	43	良好	700	44	7.5	13	無し	無し

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【００２５】表５に示すように、本発明合金Ｎｏ．１～２２は、いずれの特性も良好である。一方、表６に示すように、比較合金Ｎｏ．２３～４３は一部の成分が本発明に規定する範囲を外れるため、いずれかの特性が劣っている。なお、Ｎｏ．４２及び４３は、Ｍｇ及びＳの含有量が本発明の規定範囲に含まれるものの、式（１）又は式（２）の範囲を外れるため、銀めっき性あるいはスタンピング加工性が劣る。

【００２６】また、表１のＮｏ．２の合金については、結晶粒径の影響を見るために中間の２０秒間の熱処理の＊温度を変え（他の加工熱処理工程等は表５の実施例Ｎｏ．２と同じ）、上記と同じ試験に供した。その結果を表７に示す。表７に示すように、２０秒間の熱処理の温度が低く再結晶が起こらなかったＮｏ．２－２はファイバー組織となり、Ｎｏ．２とほぼ同等の特性が得られたが、熱処理の温度が高かったＮｏ．２－３は、平均結晶粒径が大きく、スタンピング加工性がＮｏ．２より低くなっている。

【００２７】

【表７】

表-7

No.	熱間加工性	引張強さ (N/mm²)	導電率 (%IACS)	平均結晶粒径(μm)	ばり高さ (μm)	銀突起有無	はんだ剥離 有無
2	良好	730	43	7.5	5	無し	無し
2-2	良好	710	43	ファイバー状	4	無し	無し
2-3	良好	740	42	25	12	無し	無し

【００２８】

【発明の効果】本発明の銅合金は、電気・電子部品用と※して要求される強度、導電率、はんだの耐熱剥離性などの特性を満足するとともに、例えば半導体装置のリード

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フレームや端子、コネクタなどの電気・電子部品をスタンピング加工したときに、ばり高さが小さいため、寸法精度ひいては打抜き金型の使用寿命を著しく向上させることができる。また、銀めっきした時の銀突起の発生を

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抑制することができる。従って、本発明は、電気・電子部品の生産性並びに信頼性向上に対する寄与が大である。

フロントページの続き

(72)発明者　三輪　洋介
山口県下関市長府港町14番１号　株式会社神戸製鋼所長府製造所内

(72)発明者　磯野　誠昭
山口県下関市長府港町14番１号　株式会社神戸製鋼所長府製造所内

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(71)Applicant : **KOBE STEEL LTD**
(72)Inventor : **OGURA TETSUZO**
HOSOKAWA ISAO
HAMAMOTO TAKASHI
MIWA YOSUKE
ISONO MASAAKI

(54) HIGH STRENGTH COPPER ALLOY EXCELLENT IN STAMPING PROPERTY AND SUITABLE FOR SILVER PLATING

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a Gu-Ni-Si type high strength copper alloy excellent in silver plating suitableness as well as in stamping property.
SOLUTION: This high strength copper alloy has a composition which consists of, by weight, 0.4-4.0% Ni, 0.05-1.0% Si, 0.001-5% Sn, 0.1-5.0% Zn, 0.005-1.0% Mg, 0.0003-0.005% S, 0.0003-0.01% C, and the balance Cu with inevitable impurities and in which respective contents of Mg and S simultaneously satisfy the following (1) and (2): (1) -0.5[Mg]+0.005≤ [S]; (2) [S] ≤0.25[Mg]. In the above inequalities, [Mg] and [S] represent respective weight percentages of Mg and S.

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CLAIMS

[Claim]
[Claim 1] nickel: 0.4 - 4.0wt% and Si:0.05 - 1.0wt% and Sn:0.001 - 5.0wt%, Zn: 0.1 - 5.0wt% and Mg:0.005 - 1.0wt%, and S:0.0003 - 0.005wt %, The Koriki copper alloy which is excellent in the stamping workability and silver plating nature which are characterized by containing C:0.0003 - 0.01wt%, consisting of the remainder Cu and an unescapable impurity, and the content of Mg and S filling the following formula (1) and (2) simultaneously further.
0.5[Mg]+[S] >=0.005 .... (1)
0.25 [Mg] >= [S] .... (2)
(It is the same the following as which [Mg] means wt% of Mg and [S] means wt% of S)
[Claim 2] nickel: 0.4 - 4.0wt% and Si:0.05 - 1.0wt% and Sn:0.001 - 5.0wt%, Zn: 0.1 - 5.0wt% and Mg:0.005 - 1.0wt%, and S:0.0003 - 0.005wt %, While C:0.0003 - 0.01wt% is contained, it consists of the remainder Cu and an unescapable impurity and the content of Mg and S fills the following formula (1) and (2) simultaneously further The Koriki copper alloy which is excellent in the stamping workability and silver plating nature which are characterized by the diameter of mean crystal grain of the orientation of board thickness being 20 micrometers or less.
0.5[Mg]+[S] >=0.005 .... (1)
0.25 [Mg] >= [S] .... (2)
[Claim 3] nickel: 0.4 - 4.0wt% and Si:0.05 - 1.0wt% and Sn:0.001 - 5.0wt%, Zn: 0.1 - 5.0wt% and Mg:0.005 - 1.0wt%, and S:0.0003 - 0.005wt %, C:0.0003 - 0.01wt% is contained. as an accessory constituent Be, B, aluminum, P, Ti, V, Cr, Mn, Fe, Co, Pb, calcium, Zr, It contains. the inside of Nb, Mo, Ag, In, Sb, Hf, and Ta -- one sort or two sorts or more -- a total amount -- 0.001 - 1.0wt% -- The Koriki copper alloy which is excellent in the stamping workability and silver plating nature which are characterized by consisting of the remainder Cu and an unescapable impurity, and Mg and S filling the following formula (1) and (2) simultaneously further.
0.5[Mg]+[S] >=0.005 .... (1)
0.25 [Mg] >= [S] .... (2)
[Claim 4] nickel: 0.4 - 4.0wt% and Si:0.05 - 1.0wt% and Sn:0.001 - 5.0wt%, Zn: 0.1 - 5.0wt% and Mg:0.005 - 1.0wt%, and S:0.0003 - 0.005wt %, C:0.0003 - 0.01wt% is contained. as an accessory constituent Be, B, aluminum, P, Ti, V, Cr, Mn, Fe, Co, Pb, calcium, Zr, the inside of Nb, Mo; Ag, In, Sb, Hf, and Ta -- one sort or two sorts or more -- a total amount -- 0.001 - 1.0wt%, while it contains, it consists of the remainder Cu and an unescapable impurity and Mg and S fill the following formula (1) and (2) simultaneously further The Koriki copper alloy which is excellent in the stamping workability and silver plating nature which are characterized by the diameter of mean crystal grain of the orientation of board thickness being 20 micrometers or less.
0.5[Mg]+[S] >=0.005 .... (1)
0.25 [Mg] >= [S] .... (2)

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DETAILED DESCRIPTION

[Detailed description]
[0001]
[The technical field to which invention belongs] this invention relates to the Koriki copper alloy which is excellent in the stamping workability and silver plating nature which are used for the electrical and electric equipment and electronic parts, such as a semiconductor leadframe, a terminal, a connector, a relay, and a switch.
[0002]
[Prior art] Since a Cu-nickel-Si system copper alloy combines an intensity and conductivity, it is widely used for the electrical and electric equipment and electronic parts, such as a semiconductor leadframe, a terminal, and a connector. In recent years, in connection with a miniaturization of the electrical and electric equipment and electronic parts, lightweight-izing, and high integration, reduction of the lead spacing of a leadframe or reduction of the pitch between poles of a connector is achieved. thereby -- a demand of high-intensity-izing and a raise in conductivity -- from the first -- stamping workability (there are little the burr after a stamping manipulation, who, etc.) -- excelling -- a stamping -- the demand of a material which does not wear metal mold is increasing (for example, refer to publication-number 66130 [two to] official report) Moreover, although silver plating of these electrical and electric equipment and the electronic parts may be carried out, also compared with the former, silver plating nature comes to attach importance to them by enhancement demand increase of a reliability (for example, refer to a Provisional-Publication-No. 130739 [63 to] official report, a publication-number 59468 [five to] official report, and a publication-number 319528 [eight to] official report).
[0003]
[Object of the Invention] In the electrical and electric equipment and the Cu-nickel-Si system copper alloy for electronic parts, Mg is used as an alloying element which suppresses a fall of conductivity and aims at enhancement in an intensity. And although an effect is large also to a reduction of stamping workability and a golden wearing of die as Mg is indicated by the above-mentioned publication-number 66130 [two to] official report, on the other hand, it is known that a minute amount will also degrade silver plating nature (a salient of silver plating is generated). It aims at reconciling the property considered to conflict conventionally called stamping workability and silver plating nature in the Cu-nickel-Si system Koriki copper alloy in which this invention contains Mg.
[0004]
[The means for solving a technical problem] The Koriki copper alloy which is excellent in the stamping workability and silver plating nature concerning this invention nickel: 0.4 - 4.0wt% and Si:0.05 - 1.0wt% and Sn:0.001 - 5.0wt%, Zn: 0.1 - 5.0wt% and Mg:0.005 - 1.0wt%, and S:0.0003 - 0.005wt %, C:0.0003 - 0.01wt% is contained, and it consists of the remainder Cu and an unescapable impurity, and is characterized by the content of Mg and S filling the following formula (1) and (2) simultaneously further.
$0.5[Mg]+[S] >= 0.005$ .... (1)
$0.25 [Mg] >= [S]$ .... (2)
[0005] the above-mentioned copper alloy -- accessory constituent ****** -- the inside of Be, B, aluminum, P, Ti, V, Cr, Mn, Fe, Co, Pb, calcium, Zr, Nb, Mo, Ag, In, Sb, Hf, and Ta -- one sort or two sorts or more -- a total amount -- 0.001 - 1.0wt% -- it can contain Moreover, it is desirable that the diameter of mean crystal grain of the orientation of board thickness is 20 micrometers or less.
[0006]
[Gestalt of implementation of invention] Hereafter, the component of the copper alloy concerning this invention and the ground for limitation of the diameter of crystal grain are explained.
(nickel) By adding with Si, nickel is an element which has the operation which generates the compound of nickel and Si and raises the intensity of an alloy. However, this effect is small, and since hot-working nature and cold-working nature will deteriorate if 4.0wt% is exceeded and contained, it is not desirable less than [0.4wt%]. Therefore, the content of nickel may be 0.4 - 4.0wt%.
[0007] (Si) By adding with nickel, Si is an element which has the operation which generates the compound of nickel and Si and raises the intensity of an alloy. However, if this effect is small, and 1.0wt% is exceeded and being contained, since hot-working nature and cold-working nature will deteriorate, it is not desirable less than [0.05wt%]. Therefore, the content of Si may be 0.05 - 1.0wt%.
[0008] (Sn) Sn is an element which raises an intensity, a spring property, and a stress relaxation characteristic-proof. However, this effect is small, and since it causes a degradation of hot-working nature, and a fall of conductivity while an effect is saturated, even if it exceeds and contains 5.0wt%, it is not desirable less than [0.001wt%].
[0009] (Zn) Zn is an element which raises tin and the heat-resistant detachability of tin-alloy plating, and also raises migration-proof nature further. However, these effects are small, and since they cause a fall of conductivity, and increase of a stress corrosion crack sensitivity-proof while an effect is saturated, even if it exceeds and contains 5.0wt%, they are not desirable less than [0.1wt%]. Therefore, the content of Zn may be 0.1 - 5.0wt%.
[0010] (Mg) Mg is an element which has an effect also in a reduction of a golden wearing of die while it raises an intensity, a stress relaxation characteristic-proof, and stamping workability. 0. The effect is small, and since it causes a degradation of a fluidity and hot-working nature, and a fall of conductivity while the effect is saturated, even if it exceeds and contains 1.0wt%, it is not desirable less than

[005wt%]. Therefore, the content of Mg may be 0.005 - 1.0wt%. Furthermore, Mg participates also in silver plating nature by the interaction with S as it is described below.
[0011] (S) While S raises stamping workability with Mg, it is also the element which is easy to make it generate the silver salient at the time of silver plating. 0. Less than [0003wt%], if the effect of raising stamping workability is small and exceeds and contains 0.005wt%, silver plating nature and hot-working nature will be degraded. Therefore, the content of S may be 0.0003 - 0.005wt%.
[0012] (Relation between Mg and S) In the Cu-nickel-Si system Koriki copper alloy containing Mg, since stamping workability and silver plating nature were reconciled, this invention persons found out that it was necessary to limit both components to the following domains. First, more ones of Mg and S from the field of stamping workability are desirable, and it is required to fill the following formula (1) at worst.
0.5[Mg]+[S] >=0.005 .... (1)
[0013] Next, it is required to control the proportion by the following views from the field of silver plating nature. That is, the cause of main of a silver salient is MgS which Mg and S combined and generated, and when it localizes in a copper alloy, it is for the local potential of the fraction to become low and for a local precipitation of silver to happen. However, if there are fully many contents of Mg, in order that Mg which ****s in copper may make small the potential difference between the matrix of a copper alloy, and MgS, a local precipitation of silver seldom comes to happen. Therefore, more ones of Mg are desirable by the proportion with S, and it is required to fill the following formula (2) at worst.
0.25 [Mg] >= [S] .... (2)
[0014] (C) This invention persons found out that C had the operation which raises the stamping workability of the Cu-nickel-Si system copper alloy containing Mg. However, if the effect is small and 0.01wt% is exceeded and contained, while the effect will be saturated with less than [0.0003wt%], hot-working nature is degraded. therefore, the content of C -- 0.0003 - 0.01wt% -- you may be 0.001 - 0.01wt% preferably
[0015] (Accessory constituent) The accessory constituent of Be, B, aluminum, P, Ti, V, Cr, Mn, Fe, Co, Pb, calcium, Zr, Nb, Mo, Ag, In, Sb, Hf, and Ta is the purpose which raises an intensity and stamping workability further, and is the element which can be added in the domain allowed a fall of conductivity. The enhancement effect in on the strength has one sort or two sorts or more of small total amounts of these elements less than [0.001wt%], and a fall of conductivity becomes remarkable and is not desirable if 1wt% is exceeded and contained. Therefore, the total amount of these accessory constituents is made into 0.001 - 1wt%.
[0016] (Diameter of crystal grain) In the Cu-nickel-Si system copper alloy containing Mg, this invention persons found out that the diameter of crystal grain of the orientation of board thickness participated in stamping workability especially. Stamping workability can be raised if the diameter of mean crystal grain of the orientation of board thickness in the last plate product status is 20 micrometers or less. It is 15 micrometers or less desirably. It is contained in this when crystal grain serves as **** by subsequent cold working though it is the diameter of crystal grain which exceeds 20 micrometers in a recrystallization phase, and the diameter of mean crystal grain of the orientation of board thickness is set to 20 micrometers or less. In addition, in the so-called fiber organization accepted in the material which gave cold working of a total of 90% or more after recrystallization, although crystal grain is difficult to observe, such a fiber organization is also included in this invention.
[0017]
[Example] The example of the Koriki copper alloy which is excellent in the stamping workability and silver plating nature concerning this invention is explained below with the example of a comparison. The atmospheric-air lysis of the copper alloy of the component composition shown in Tables 1-4 was carried out under charcoal covering in the kryptol furnace, it was cast to the book mold, and the 50mmx80mmx200mm ingot was produced. This ingot was heated at 930 degrees C, and after hot rolling, the water quenching was carried out immediately and it considered as **** material with a thickness of 15mm. In order to remove the scale of the front face of this **** material, the front face was cut by the grinder. This **** material was carried out in thickness of 0.36mm by the cold rolling, and the water quenching was carried out after heat-treating for 20 seconds at 650-850 degrees C. Furthermore, the cold rolling was carried out to 0.25mm in thickness, the annealing of 2 hours was given at 450-500 degrees C, and the examination after elimination was presented with the surface oxide film in the pickling.
[0018]
[Table 1]

表-1

		主成分（wt%）							副成分
	No.	Cu	Ni	Si	Sn	Zn	Mg	S	C	(wt%)
実施例	1	残部	0.9	0.2	0.5	1.0	0.10	0.0015	0.0030	−
	2	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	−
	3	残部	3.2	0.7	0.5	1.0	0.10	0.0015	0.0030	−
	4	残部	1.8	0.4	0.01	1.0	0.10	0.0015	0.0030	−
	5	残部	1.8	0.4	0.1	1.0	0.10	0.0015	0.0030	−
	6	残部	1.8	0.4	3.0	1.0	0.10	0.0015	0.0030	−
	7	残部	1.8	0.4	0.5	0.3	0.10	0.0015	0.0030	−
	8	残部	1.8	0.4	0.5	3.0	0.10	0.0015	0.0030	−
	9	残部	1.8	0.4	0.5	1.0	0.01	0.0015	0.0030	−
	10	残部	1.8	0.4	0.5	1.0	0.30	0.0015	0.0030	−
	11	残部	1.8	0.4	0.5	1.0	0.70	0.0015	0.0030	−
	12	残部	1.8	0.4	0.5	1.0	0.10	0.0005	0.0030	−
	13	残部	1.8	0.4	0.5	1.0	0.10	0.0040	0.0030	−
	14	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0015	−
	15	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0080	−

[0019]
[Table 2]

表-2

		主成分（wt%）							副成分
	No.	Cu	Ni	Si	Sn	Zn	Mg	S	C	(wt%)
実施例	16	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Be : 0.1 B : 0.04 Al : 0.008
	17	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	P : 0.03 Ti : 0.02 V : 0.006
	18	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Cr : 0.005 Mn : 0.04 Fe : 0.02
	19	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Co : 0.03 Zr : 0.02 Nb : 0.01
	20	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Mo : 0.005 Ag : 0.03 In : 0.08
	21	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Sb : 0.07 Hf : 0.009 Ta : 0.01
	22	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Pb : 0.02 Ca : 0.005

[0020]
[Table 3]

表-3

	No.	主成分（wt%） Cu	Ni	Si	Sn	Zn	Mg	S	C	副成分 (wt%)
比較例	23	残部	0.3	0.4	0.5	1.0	0.10	0.0015	0.0030	—
	24	残部	4.5	0.4	0.5	1.0	0.10	0.0015	0.0030	—
	25	残部	5.0	1.1	0.5	1.0	0.10	0.0015	0.0030	—
	26	残部	1.8	0.4	0.0005	1.0	0.10	0.0015	0.0030	—
	27	残部	1.8	0.4	6.0	1.0	0.10	0.0015	0.0030	—
	28	残部	1.8	0.4	0.5	0.05	0.10	0.0015	0.0030	—
	29	残部	1.8	0.4	0.5	6.0	0.10	0.0015	0.0030	—
	30	残部	1.8	0.4	0.5	1.0	0.003	0.0015	0.0030	—
	31	残部	1.8	0.4	0.5	1.0	1.2	0.0015	0.0030	—
	32	残部	1.8	0.4	0.5	1.0	0.10	0.0002	0.0030	—
	33	残部	1.8	0.4	0.5	1.0	0.10	0.006	0.0030	—
	34	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0001	—
	35	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0120	—

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[0021]
[Table 4]

表-4

	No.	主成分（wt%） Cu	Ni	Si	Sn	Zn	Mg	S	C	副成分 (wt%)
比較例	36	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Be : 0.1 * B : 0.04 Al : 1.2
	37	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	P : 0.6 * Ti : 0.5 V : 0.006
	38	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Cr : 0.5 * Mn : 0.04 Fe : 0.7
	39	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Co : 1.3 * Zr : 0.02 Nb : 0.01
	40	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Mo : 0.005 Ag : 0.03 In : 1.2 *
	41	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Sb : 1.1 * Hf : 0.009 Ta : 0.01
	42	残部	1.8	0.4	0.5	1.0	0.015	0.004	0.0030	—
	43	残部	1.8	0.4	0.5	1.0	0.006	0.0015	0.0030	—

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[0022] About this test specimen, tensile strength, conductivity, the diameter of crystal grain, stamping workability, silver plating nature, and the solder heat-proof detachability were investigated in the following way. These results are shown in Table 5 and 6. JIS test piece of No. 5 was used for tensile strength. Conductivity was measured by the double bridge method. The diameter of crystal grain was measured in the

orientation of board thickness by the intercept method of the copper elongation article grain-size-number test method specified to JISH0501. Evaluation of stamping workability pierced the lead with a length [of 30mm], and a width of face of 0.5mm with a press, and measured the height of a burr. Silver plating nature observed the existence of the phenomenon (salient) in which plating thickness becomes thick locally, by the stereoscopic microscope, when cyanogen system silver plating was performed 1 micrometer in thickness. After the solder heat-proof detachability bent 180 degrees of the materials which were immersed in the 245-degree C solder bath (60Sn/40Pb) for 5 seconds, and covered about 20-micrometer plating layer and returned them monotonously after 1000 hour heating at 150 degrees C, it observed the existence of sublation of a solder plating layer.

[0023]

[Table 5]

表-5

	No.	熱間加工性	引張強さ (N/mm²)	導電率 (%IACS)	平均結晶粒径(μm)	ばり高さ (μm)	銀突起有無	はんだ剥離 有無
実施例	1	良好	580	45	7.5	8	無し	無し
	2	良好	730	43	7.5	5	無し	無し
	3	良好	900	40	7.5	3	無し	無し
	4	良好	710	48	7.5	5	無し	無し
	5	良好	720	47	7.5	5	無し	無し
	6	良好	770	30	7.5	5	無し	無し
	7	良好	720	44	7.5	5	無し	無し
	8	良好	740	42	7.5	5	無し	無し
	9	良好	710	44	7.5	7	無し	無し
	10	良好	750	41	7.5	4	無し	無し
	11	良好	780	38	7.5	3	無し	無し
	12	良好	730	43	7.5	7	無し	無し
	13	良好	730	43	7.5	3	無し	無し
	14	良好	730	43	7.5	7	無し	無し
	15	良好	730	43	7.5	3	無し	無し
	16	良好	800	37	7.5	3	無し	無し
	17	良好	770	38	7.5	3	無し	無し
	18	良好	740	42	7.5	4	無し	無し
	19	良好	750	42	7.5	4	無し	無し
	20	良好	760	41	7.5	3	無し	無し
	21	良好	750	41	7.5	3	無し	無し
	22	良好	750	41	7.5	2	無し	無し

[0024]

[Table 6]

表-6

	No.	熱間加工性	引張強さ (N/mm²)	導電率 (%IACS)	平均結晶粒径(μm)	ばり高さ (μm)	銀突起有無	はんだ剥離 有無
比較例	23	良好	530	36	7.5	10	無し	無し
	24	割れ	—	—	—	—	—	—
	25	割れ	—	—	—	—	—	—
	26	良好	700	43	7.5	5	無し	無し
	27	割れ	—	—	—	—	—	—
	28	良好	730	45	7.5	5	無し	有り
	29	良好	740	34	7.5	5	無し	無し
	30	良好	690	44	7.5	16	無し	無し
	31	割れ	—	—	—	—	—	—
	32	良好	780	38	7.5	15	無し	無し
	33	割れ	—	—	—	—	—	—
	34	良好	730	43	7.5	17	無し	無し
	35	割れ	—	—	—	—	—	—
	36	良好	890	24	7.5	3	無し	無し
	37	良好	960	9	7.5	3	無し	無し
	38	良好	770	31	7.5	3	無し	無し
	39	良好	760	29	7.5	3	無し	無し
	40	良好	790	30	7.5	3	無し	無し
	41	良好	800	28	7.5	3	無し	無し
	42	良好	710	43	7.5	5	有り	無し
	43	良好	700	44	7.5	13	無し	無し

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[0025] As shown in Table 5, any property of this invention alloy No.1-22 is good. On the other hand, as shown in Table 6, since a part of component separates from the domain specified to this invention, one of properties are inferior in comparison alloy No.23-43. In addition, it reaches No.42, and 43 is inferior in silver plating nature or stamping workability, in order to separate from the domain of a formula (1) or a formula (2), although the content of Mg and S is contained in the convention domain of this invention.

[0026] moreover, about the alloy of No.2 of Table 1, in order to see the influence of the diameter of crystal grain, the temperature of middle heat treatment for 20 seconds was changed (others -- a thermomechanical-treatment process etc. is the same as that of example No.2 of Table 5), and the same examination as the above was presented The result is shown in Table 7. Although No.2-2 to which the temperature of heat treatment for 20 seconds is low, and recrystallization did not happen become a fiber organization and the property almost equivalent to No.2 was acquired as shown in Table 7, No.2-3 whose temperature of heat treatment was high have a large diameter of mean crystal grain, and stamping workability is low from No.2.

[0027]

[Table 7]

表-7

No.	熱間加工性	引張強さ (N/mm²)	導電率 (%IACS)	平均結晶粒径(μm)	ばり高さ (μm)	銀突起有無	はんだ剥離 有無
2	良好	730	43	7.5	5	無し	無し
2-2	良好	710	43	ﾌｧｲﾊﾞｰ状	4	無し	無し
2-3	良好	740	42	25	12	無し	無し

[0028]

[Effect of the invention] If a burr height pulls the copper alloy of this invention the degree of dimension energy for a parvus reason when the stamping manipulation of the electrical and electric equipment and the electronic parts, such as a leadframe of a semiconductor device, and a

terminal, a connector, is carried out, for example while properties, such as an intensity demanded as the electrical and electric equipment and an object for electronic parts, conductivity, and the heat-resistant detachability of solder, are satisfied, it can raise a blanking golden service life of die remarkably. Moreover, occurrence of the silver salient when carrying out silver plating can be suppressed. Therefore, contribution of as opposed to the productivity of the electrical and electric equipment and electronic parts and the enhancement in a reliability in this invention is size.

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TECHNICAL FIELD

[The technical field to which invention belongs] this invention relates to the Koriki copper alloy which is excellent in the stamping workability and silver plating nature which are used for the electrical and electric equipment and electronic parts, such as a semiconductor leadframe, a terminal, a connector, a relay, and a switch.

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PRIOR ART

[Prior art] Since a Cu-nickel-Si system copper alloy combines an intensity and conductivity, it is widely used for the electrical and electric equipment and electronic parts, such as a semiconductor leadframe, a terminal, and a connector. In recent years, in connection with a miniaturization of the electrical and electric equipment and electronic parts, lightweight-izing, and high integration, reduction of the lead spacing of a leadframe or reduction of the pitch between poles of a connector is achieved. thereby -- a demand of high-intensity-izing and a raise in conductivity -- from the first -- stamping workability (there are little the burr after a stamping manipulation, who, etc.) -- excelling -- a stamping -- the demand of a material which does not wear metal mold is increasing (for example, refer to publication-number 66130 [two to] official report) Moreover, although silver plating of these electrical and electric equipment and the electronic parts may be carried out, also compared with the former, silver plating nature comes to attach importance to them by enhancement demand increase of a reliability (for example, refer to a Provisional-Publication-No. 130739 [63 to] official report, a publication-number 59468 [five to] official report, and a publication-number 319528 [eight to] official report).

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EFFECT OF THE INVENTION

[Effect of the invention] If a burr height pulls the copper alloy of this invention the degree of dimension energy for a parvus reason when the stamping manipulation of the electrical and electric equipment and the electronic parts, such as a leadframe of a semiconductor device, and a terminal, a connector, is carried out, for example while properties, such as an intensity demanded as the electrical and electric equipment and an object for electronic parts, conductivity, and the heat-resistant detachability of solder, are satisfied, it can raise a blanking golden service life of die remarkably. Moreover, occurrence of the silver salient when carrying out silver plating can be suppressed. Therefore, contribution of as opposed to the productivity of the electrical and electric equipment and electronic parts and the enhancement in a reliability in this invention is size.

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TECHNICAL PROBLEM

[Object of the Invention] In the electrical and electric equipment and the Cu-nickel-Si system copper alloy for electronic parts, Mg is used as an alloying element which suppresses a fall of conductivity and aims at enhancement in an intensity. And although an effect is large also to a reduction of stamping workability and a golden wearing of die as Mg is indicated by the above-mentioned publication-number 66130 [two to] official report, on the other hand, it is known that a minute amount will also degrade silver plating nature (a salient of silver plating is generated). It aims at reconciling the property considered to conflict conventionally called stamping workability and silver plating nature in the Cu-nickel-Si system Koriki copper alloy in which this invention contains Mg.

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MEANS

[The means for solving a technical problem] The Koriki copper alloy which is excellent in the stamping workability and silver plating nature concerning this invention nickel: 0.4 - 4.0wt% and Si:0.05 - 1.0wt% and Sn:0.001 - 5.0wt%, Zn: 0.1 - 5.0wt% and Mg:0.005 - 1.0wt%, and S:0.0003 - 0.005wt %, C:0.0003 - 0.01wt% is contained, and it consists of the remainder Cu and an unescapable impurity, and is characterized by the content of Mg and S filling the following formula (1) and (2) simultaneously further.

0.5[Mg]+[S] >=0.005 .... (1)

0.25 [Mg] >= [S] .... (2)

[0005] the above-mentioned copper alloy -- accessory constituent ****** -- the inside of Be, B, aluminum, P, Ti, V, Cr, Mn, Fe, Co, Pb, calcium, Zr, Nb, Mo, Ag, In, Sb, Hf, and Ta -- one sort or two sorts or more -- a total amount -- 0.001 - 1.0wt% -- it can contain Moreover, it is desirable that the diameter of mean crystal grain of the orientation of board thickness is 20 micrometers or less.

[0006]

[Gestalt of implementation of invention] Hereafter, the component of the copper alloy concerning this invention and the ground for limitation of the diameter of crystal grain are explained.

(nickel) By adding with Si, nickel is an element which has the operation which generates the compound of nickel and Si and raises the intensity of an alloy. However, this effect is small, and since hot-working nature and cold-working nature will deteriorate if 4.0wt% is exceeded and contained, it is not desirable less than [0.4wt%]. Therefore, the content of nickel may be 0.4 - 4.0wt%.

[0007] (Si) By adding with nickel, Si is an element which has the operation which generates the compound of nickel and Si and raises the intensity of an alloy. However, if this effect is small, and 1.0wt% is exceeded and being contained, since hot-working nature and cold-working nature will deteriorate, it is not desirable less than [0.05wt%]. Therefore, the content of Si may be 0.05 - 1.0wt%.

[0008] (Sn) Sn is an element which raises an intensity, a spring property, and a stress relaxation characteristic-proof. However, this effect is small, and since it causes a degradation of hot-working nature, and a fall of conductivity while an effect is saturated, even if it exceeds and contains 5.0wt%, it is not desirable less than [0.001wt%].

[0009] (Zn) Zn is an element which raises tin and the heat-resistant detachability of tin-alloy plating, and also raises migration-proof nature further. However, these effects are small, and since they cause a fall of conductivity, and increase of a stress corrosion crack sensitivity-proof while an effect is saturated, even if it exceeds and contains 5.0wt%, they are not desirable less than [0.1wt%]. Therefore, the content of Zn may be 0.1 - 5.0wt%.

[0010] (Mg) Mg is an element which has an effect also in a reduction of a golden wearing of die while it raises an intensity, a stress relaxation characteristic-proof, and stamping workability. 0. The effect is small, and since it causes a degradation of a fluidity and hot-working nature, and a fall of conductivity while the effect is saturated, even if it exceeds and contains 1.0wt%, it is not desirable less than [005wt%]. Therefore, the content of Mg may be 0.005 - 1.0wt%. Furthermore, Mg participates also in silver plating nature by the interaction with S as it is described below.

[0011] (S) While S raises stamping workability with Mg, it is also the element which is easy to make it generate the silver salient at the time of silver plating. 0. Less than [0003wt%], if the effect of raising stamping workability is small and exceeds and contains 0.005wt%, silver plating nature and hot-working nature will be degraded. Therefore, the content of S may be 0.0003 - 0.005wt%.

[0012] (Relation between Mg and S) In the Cu-nickel-Si system Koriki copper alloy containing Mg, since stamping workability and silver plating nature were reconciled, this invention persons found out that it was necessary to limit both components to the following domains. First, more ones of Mg and S from the field of stamping workability are desirable, and it is required to fill the following formula (1) at worst.

0.5[Mg]+[S] >=0.005 .... (1)

[0013] Next, it is required to control the proportion by the following views from the field of silver plating nature. That is, the cause of main of a silver salient is MgS which Mg and S combined and generated, and when it localizes in a copper alloy, it is for the local potential of the fraction to become low and for a local precipitation of silver to happen. However, if there are fully many contents of Mg, in order that Mg which ****s in copper may make small the potential difference between the matrix of a copper alloy, and MgS, a local precipitation of silver seldom comes to happen. Therefore, more ones of Mg are desirable by the proportion with S, and it is required to fill the following formula (2) at worst.

0.25 [Mg] >= [S] .... (2)

[0014] (C) This invention persons found out that C had the operation which raises the stamping workability of the Cu-nickel-Si system copper alloy containing Mg. However, if the effect is small and 0.01wt% is exceeded and contained, while the effect will be saturated with less than [0.0003wt%], hot-working nature is degraded. therefore, the content of C -- 0.0003 - 0.01wt% -- you may be 0.001 - 0.01wt% preferably

[0015] (Accessory constituent) The accessory constituent of Be, B, aluminum, P, Ti, V, Cr, Mn, Fe, Co, Pb, calcium, Zr, Nb, Mo, Ag, In, Sb, Hf, and Ta is the purpose which raises an intensity and stamping workability further, and is the element which can be added in the domain allowed a fall of conductivity. The enhancement effect in on the strength has one sort or two sorts or more of small total amounts of these elements less than [0.001wt%], and a fall of conductivity becomes remarkable and is not desirable if 1wt% is exceeded and contained.

Therefore, the total amount of these accessory constituents is made into 0.001 - 1wt%.

[0016] (Diameter of crystal grain) In the Cu-nickel-Si system copper alloy containing Mg, this invention persons found out that the diameter of crystal grain of the orientation of board thickness participated in stamping workability especially. Stamping workability can be raised if the diameter of mean crystal grain of the orientation of board thickness in the last plate product status is 20 micrometers or less. It is 15 micrometers or less desirably. It is contained in this when crystal grain serves as **** by subsequent cold working though it is the diameter of crystal grain which exceeds 20 micrometers in a recrystallization phase, and the diameter of mean crystal grain of the orientation of board thickness is set to 20 micrometers or less. In addition, in the so-called fiber organization accepted in the material which gave cold working of a total of 90% or more after recrystallization, although crystal grain is difficult to observe, such a fiber organization is also included in this invention.

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EXAMPLE

[Example] The example of the Koriki copper alloy which is excellent in the stamping workability and silver plating nature concerning this invention is explained below with the example of a comparison. The atmospheric-air lysis of the copper alloy of the component composition shown in Tables 1-4 was carried out under charcoal covering in the kryptol furnace, it was cast to the book mold, and the 50mmx80mmx200mm ingot was produced. This ingot was heated at 930 degrees C, and after hot rolling, the water quenching was carried out immediately and it considered as **** material with a thickness of 15mm. In order to remove the scale of the front face of this **** material, the front face was cut by the grinder. This **** material was carried out in thickness of 0.36mm by the cold rolling, and the water quenching was carried out after heat-treating for 20 seconds at 650-850 degrees C. Furthermore, the cold rolling was carried out to 0.25mm in thickness, the annealing of 2 hours was given at 450-500 degrees C, and the examination after elimination was presented with the surface oxide film in the pickling.

[0018]

[Table 1]

表-1

		主成分（wt%）								副成分
	No.	Cu	Ni	Si	Sn	Zn	Mg	S	C	(wt%)
実施例	1	残部	0.9	0.2	0.5	1.0	0.10	0.0015	0.0030	-
	2	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	-
	3	残部	3.2	0.7	0.5	1.0	0.10	0.0015	0.0030	-
	4	残部	1.8	0.4	0.01	1.0	0.10	0.0015	0.0030	-
	5	残部	1.8	0.4	0.1	1.0	0.10	0.0015	0.0030	-
	6	残部	1.8	0.4	3.0	1.0	0.10	0.0015	0.0030	-
	7	残部	1.8	0.4	0.5	0.3	0.10	0.0015	0.0030	-
	8	残部	1.8	0.4	0.5	3.0	0.10	0.0015	0.0030	-
	9	残部	1.8	0.4	0.5	1.0	0.01	0.0015	0.0030	-
	10	残部	1.8	0.4	0.5	1.0	0.30	0.0015	0.0030	-
	11	残部	1.8	0.4	0.5	1.0	0.70	0.0015	0.0030	-
	12	残部	1.8	0.4	0.5	1.0	0.10	0.0005	0.0030	-
	13	残部	1.8	0.4	0.5	1.0	0.10	0.0040	0.0030	-
	14	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0015	-
	15	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0080	-

[0019]

[Table 2]

表-2

	No.	主成分（wt%） Cu	Ni	Si	Sn	Zn	Mg	S	C	副成分 (wt%)
実施例	16	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Be : 0.1 B : 0.04 Al : 0.008
	17	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	P : 0.03 Ti : 0.02 V : 0.006
	18	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Cr : 0.005 Mn : 0.04 Fe : 0.02
	19	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Co : 0.03 Zr : 0.02 Nb : 0.01
	20	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Mo : 0.005 Ag : 0.03 In : 0.08
	21	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Sb : 0.07 Hf : 0.009 Ta : 0.01
	22	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Pb : 0.02 Ca : 0.005

[0020]
[Table 3]

表-3

	No.	主成分（wt%） Cu	Ni	Si	Sn	Zn	Mg	S	C	副成分 (wt%)
比較例	23	残部	0.3	0.4	0.5	1.0	0.10	0.0015	0.0030	—
	24	残部	4.5	0.4	0.5	1.0	0.10	0.0015	0.0030	—
	25	残部	5.0	1.1	0.5	1.0	0.10	0.0015	0.0030	—
	26	残部	1.8	0.4	0.0005	1.0	0.10	0.0015	0.0030	—
	27	残部	1.8	0.4	6.0	1.0	0.10	0.0015	0.0030	—
	28	残部	1.8	0.4	0.5	0.05	0.10	0.0015	0.0030	—
	29	残部	1.8	0.4	0.5	6.0	0.10	0.0015	0.0030	—
	30	残部	1.8	0.4	0.5	1.0	0.003	0.0015	0.0030	—
	31	残部	1.8	0.4	0.5	1.0	1.2	0.0015	0.0030	—
	32	残部	1.8	0.4	0.5	1.0	0.10	0.0002	0.0030	—
	33	残部	1.8	0.4	0.5	1.0	0.10	0.006	0.0030	—
	34	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0001	—
	35	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0120	—

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[0021]
[Table 4]

表-4

	No.	主成分（wt%）								副成分 (wt%)
		Cu	Ni	Si	Sn	Zn	Mg	S	C	
比較例	36	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Be : 0.1 * B : 0.04 Al : 1.2
	37	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	P : 0.6 * Ti : 0.5 V : 0.006
	38	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Cr : 0.5 * Mn : 0.04 Fe : 0.7
	39	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Co : 1.3 * Zr : 0.02 Nb : 0.01
	40	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Mo : 0.005 Ag : 0.03 In : 1.2 *
	41	残部	1.8	0.4	0.5	1.0	0.10	0.0015	0.0030	Sb : 1.1 * Hf : 0.009 Ta : 0.01
	42	残部	1.8	0.4	0.5	1.0	0.015	0.004	0.0030	—
	43	残部	1.8	0.4	0.5	1.0	0.006	0.0015	0.0030	—

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[0022] About this test specimen, tensile strength, conductivity, the diameter of crystal grain, stamping workability, silver plating nature, and the solder heat-proof detachability were investigated in the following way. These results are shown in Table 5 and 6. JIS test piece of No. 5 was used for tensile strength. Conductivity was measured by the double bridge method. The diameter of crystal grain was measured in the orientation of board thickness by the intercept method of the copper elongation article grain-size-number test method specified to JISH0501. Evaluation of stamping workability pierced the lead with a length [of 30mm], and a width of face of 0.5mm with a press, and measured the height of a burr. Silver plating nature observed the existence of the phenomenon (salient) in which plating thickness becomes thick locally, by the stereoscopic microscope, when cyanogen system silver plating was performed 1 micrometer in thickness. After the solder heat-proof detachability bent 180 degrees of the materials which were immersed in the 245-degree C solder bath (60Sn/40Pb) for 5 seconds, and covered about 20-micrometer plating layer and returned them monotonously after 1000 hour heating at 150 degrees C, it observed the existence of sublation of a solder plating layer.

[0023]

[Table 5]

表-5

	No.	熱間加工性	引張強さ (N/mm²)	導電率 (%IACS)	平均結晶粒径(μm)	ばり高さ (μm)	銀突起有無	はんだ剥離 有無
実施例	1	良好	580	45	7.5	8	無し	無し
	2	良好	730	43	7.5	5	無し	無し
	3	良好	900	40	7.5	3	無し	無し
	4	良好	710	48	7.5	5	無し	無し
	5	良好	720	47	7.5	5	無し	無し
	6	良好	770	30	7.5	5	無し	無し
	7	良好	720	44	7.5	5	無し	無し
	8	良好	740	42	7.5	5	無し	無し
	9	良好	710	44	7.5	7	無し	無し
	10	良好	750	41	7.5	4	無し	無し
	11	良好	780	38	7.5	3	無し	無し
	12	良好	730	43	7.5	7	無し	無し
	13	良好	730	43	7.5	3	無し	無し
	14	良好	730	43	7.5	7	無し	無し
	15	良好	730	43	7.5	3	無し	無し
	16	良好	800	37	7.5	3	無し	無し
	17	良好	770	38	7.5	3	無し	無し
	18	良好	740	42	7.5	4	無し	無し
	19	良好	750	42	7.5	4	無し	無し
	20	良好	760	41	7.5	3	無し	無し

	21	良好	750	41	7.5	3	無し	無し
	22	良好	750	41	7.5	2	無し	無し

[0024]
[Table 6]

表-6

	No.	熱間加工性	引張強さ (N/mm²)	導電率 (%IACS)	平均結晶粒径(μm)	ばり高さ (μm)	銀突起有無	はんだ剥離 有無
比較例	23	良好	530	36	7.5	10	無し	無し
	24	割れ	—	—	—	—	—	—
	25	割れ	—	—	—	—	—	—
	26	良好	700	43	7.5	5	無し	無し
	27	割れ	—	—	—	—	—	—
	28	良好	730	45	7.5	5	無し	有り
	29	良好	740	34	7.5	5	無し	無し
	30	良好	690	44	7.5	16	無し	無し
	31	割れ	—	—	—	—	—	—
	32	良好	780	38	7.5	15	無し	無し
	33	割れ	—	—	—	—	—	—
	34	良好	730	43	7.5	17	無し	無し
	35	割れ	—	—	—	—	—	—
	36	良好	890	24	7.5	3	無し	無し
	37	良好	960	9	7.5	3	無し	無し
	38	良好	770	31	7.5	3	無し	無し
	39	良好	760	29	7.5	3	無し	無し
	40	良好	790	30	7.5	3	無し	無し
	41	良好	800	28	7.5	3	無し	無し
	42	良好	710	43	7.5	5	有り	無し
	43	良好	700	44	7.5	13	無し	無し

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[0025] As shown in Table 5, any property of this invention alloy No.1-22 is good. On the other hand, as shown in Table 6, since a part of component separates from the domain specified to this invention, one of properties are inferior in comparison alloy No.23-43. In addition, it reaches No.42, and 43 is inferior in silver plating nature or stamping workability, in order to separate from the domain of a formula (1) or a formula (2), although the content of Mg and S is contained in the convention domain of this invention.
[0026] moreover, about the alloy of No.2 of Table 1, in order to see the influence of the diameter of crystal grain, the temperature of middle heat treatment for 20 seconds was changed (others -- a thermomechanical-treatment process etc. is the same as that of example No.2 of Table 5), and the same examination as the above was presented The result is shown in Table 7. Although No.2-2 to which the temperature of heat treatment for 20 seconds is low, and recrystallization did not happen become a fiber organization and the property almost equivalent to No.2 was acquired as shown in Table 7, No.2-3 whose temperature of heat treatment was high have a large diameter of mean crystal grain, and stamping workability is low from No.2.
[0027]
[Table 7]

表-7

No.	熱間加工性	引張強さ (N/mm^2)	導電率 (%IACS)	平均結晶粒径 (μm)	ばり高さ (μm)	銀突起有無	はんだ剥離 有無
2	良好	730	43	7.5	5	無し	無し
2-2	良好	710	43	ﾌｧｲﾊﾞｰ状	4	無し	無し
2-3	良好	740	42	25	12	無し	無し

[Translation done.]